ANNUAL TECHNICAL PROGRESS REPORT:

Bayesian Methods for Radiation Detection and Dosimetry

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Summary:

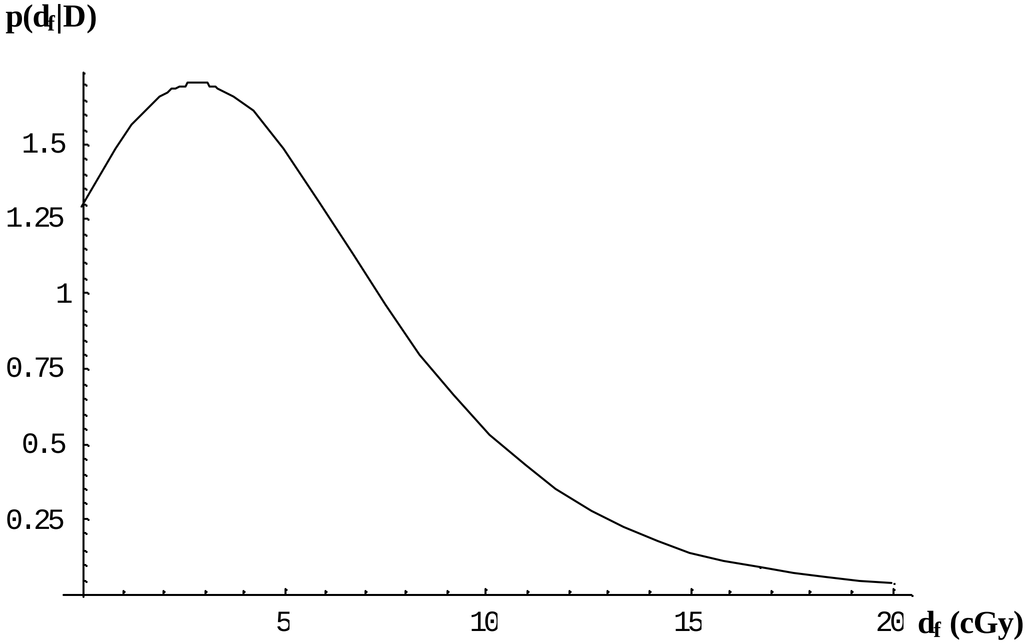
During this reporting period we presented two papers on our work in biological dosimetry using dicentric chromosome aberrations at meetings, submitted one paper on internal radiation dosimetry to Health Physics and prepared a draft of a paper on biological dosimetry with uncertain calibration doses for journal publication.

In the area of radiation detection we worked on estimation of net counting rates in the presence of background (single channel case) and began working on the analogous problem for the multi-channel case.

Some more technical details of the research in external and internal dosimetry and radiation detection follow.

External and Internal Dosimetry:

In biological dosimetry we derived calibrative densities of the unknown accident dose for linear and linear-quadratic models. The linear dose-response model is the "public" model for the production of dicentric chromosome aberrations after exposure to neutrons and the linear-quadratic model is the accepted model for exposure to low LET radiation. The calibrative density describes the remaining uncertainty about the unknown accidental dose. An example of a calibrative density for the unknown neutron dose D_f is shown on the next page.



Calibrative Density for the Unknown Neutron Dose D_f .

The calibration data for this figure are taken from a report by Inoue (Y. Inoue, Dicentric Yields Induced in Rabbit Blood Lymphocytes by Low Doses of ^{252}Cf Neutrons, JAERI 95-073, Japan Atomic Research Institute (1995).

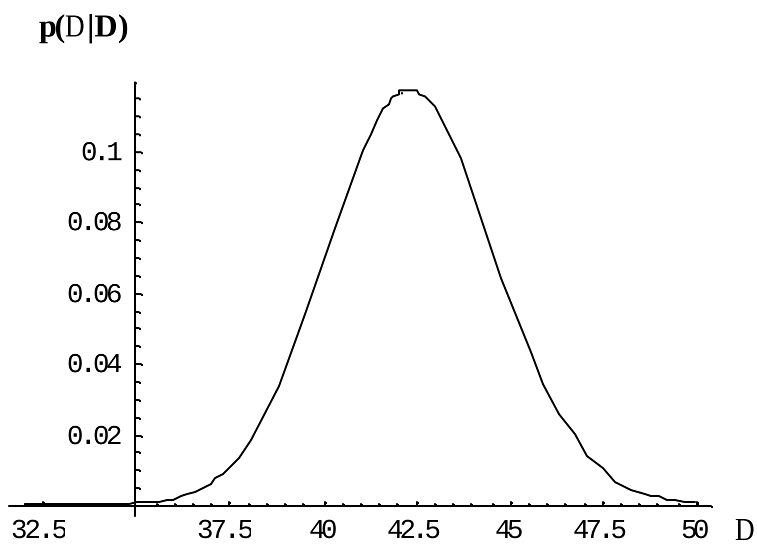
We compared the linear and linear-quadratic models for neutrons using Bayes Factors and found the linear model to be adequate for exposures to low doses of neutrons.

In internal radiation dosimetry we studied the exchange of ^{45}Ca on bone surfaces using published data on beagles. We estimated the exchange rates for ^{45}Ca for a two compartment model by deriving posterior densities for these parameters. We also used the posterior densities to predict activities in the two compartments at different times. We submitted a paper on this research to Health Physics.

A draft of a paper that considers dose uncertainty in the calibration experiment for a model linear in dose was completed.

Radiation Detection

We derived posterior densities for the net counting rate in the presence of background for the single channel case. We used a Poisson model for low count rate data and the Normal approximation to the Poisson for large counting rates. Shown below, for example, is the graph of the posterior density for the net counting rate Δ for 7.7 background counts/minute counts and 50 sample counts/minute using a Poisson model.



Posterior Density for the Net Counting Rate D.

We started work on the estimation of net-counts in the multi-channel case. We are investigating the use of a multinomial model together with Dirichlet prior distributions for this case.

Presentations and Publications:

1) ***Chromosome Dosimetry after Accidental Exposure to Radiation.***

Peter G. Groer and Scott R. Brame

Presented at the 6th World Meeting of the International Society for Bayesian Analysis (ISBA), Heraklion, Greece, May 28-June 1, 2000.

A manuscript for publication in the proceedings of this conference is in preparation.

2) ***Bayesian Estimation of Neutron Doses Using Chromosome Aberrations and Ancillary Prior Information.***

Scott R. Brame and Peter G. Groer

Presented at the American Nuclear Society 2000 Annual Meeting, San Diego, June 4-8, 2000. (Presenter Ron Pevey)

This paper was accepted for publication and will be published in the Transactions of the American Nuclear Society, 2000.

3) ***Bayesian Estimation of Calcium Exchange Rates at Bone Surfaces in Beagles.***

Yunnhon Lo and Peter G. Groer

Submitted to *Health Physics*, May 2000.